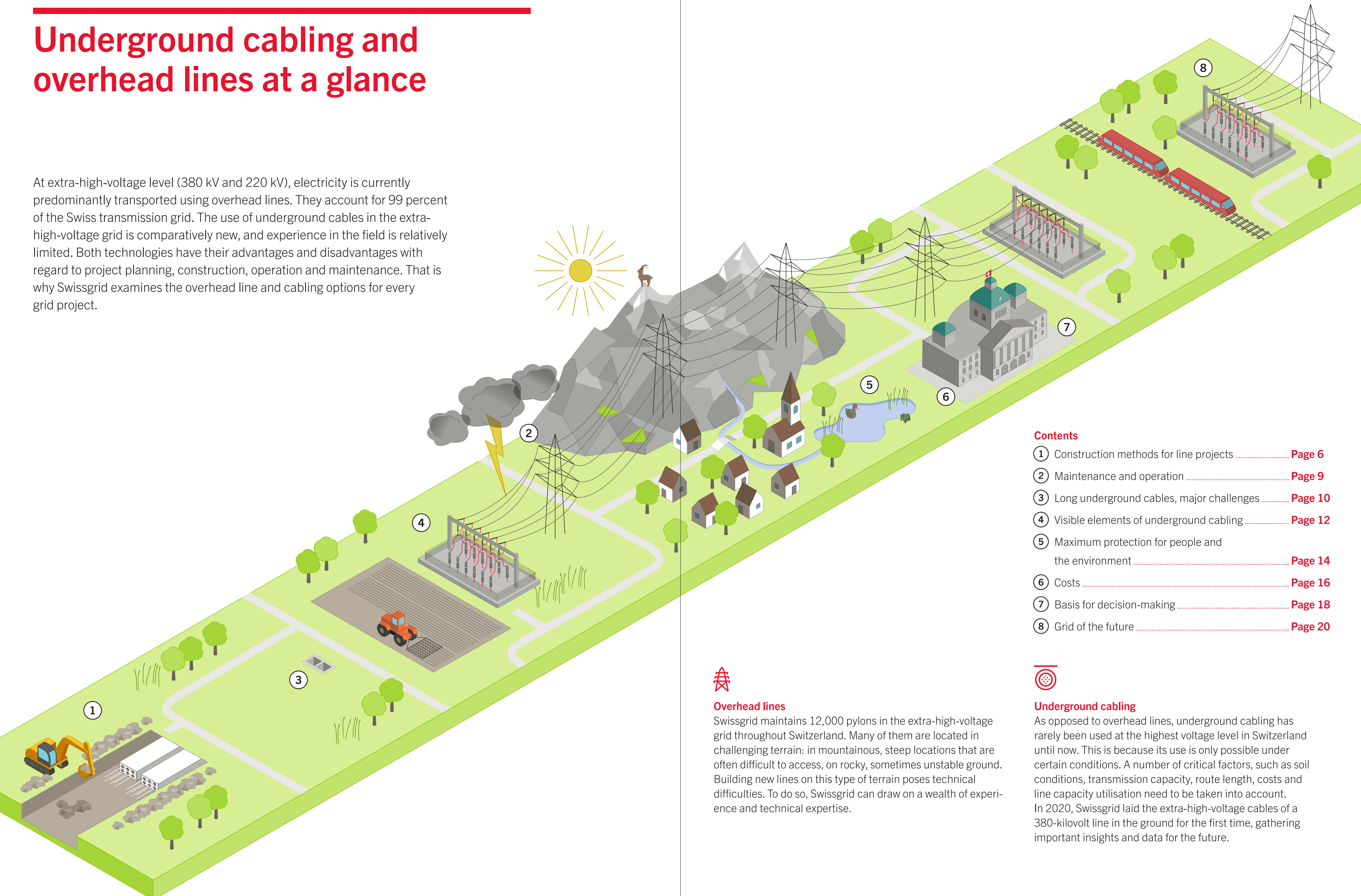
Technologies in Switzerland's extra-high-voltage grid

# Overhead lines and underground cabling

swissgrid

# Underground cabling and overhead lines at a glance

At extra-high-voltage level (380 kV and 220 kV), electricity is currently predominantly transported using overhead lines. They account for 99 percent of the Swiss transmission grid. The use of underground cables in the extra-high-voltage grid is comparatively new, and experience in the field is relatively limited. Both technologies have their advantages and disadvantages with regard to project planning, construction, operation and maintenance. That is why Swissgrid examines the overhead line and cabling options for every grid project.



**Contents**



**Overhead lines**

Swissgrid maintains 12,000 pylons in the extra-high-voltage grid throughout Switzerland. Many of them are located in challenging terrain: in mountainous, steep locations that are often difficult to access, on rocky, sometimes unstable ground. Building new lines on this type of terrain poses technical difficulties. To do so, Swissgrid can draw on a wealth of experience and technical expertise.

**Underground cabling**

As opposed to overhead lines, underground cabling has rarely been used at the highest voltage level in Switzerland until now. This is because its use is only possible under certain conditions. A number of critical factors, such as soil conditions, transmission capacity, route length, costs and line capacity utilisation need to be taken into account.
In 2020, Swissgrid laid the extra-high-voltage cables of a 380-kilovolt line in the ground for the first time, gathering important insights and data for the future.

# Expansion and modernisation of the transmission system

**The Swiss transmission grid**
With a total length of over 6,700 kilometres and 147 switchgears, the Swiss transmission grid forms the backbone of Switzerland's secure electricity supply. The role of the extra-high-voltage grid is to transport the energy generated by the power plants at a voltage of 380 or 220 kilovolts to the regional and local distribution grids, from where it reaches consumers.

**Expansion and modernisation**
The Swiss transmission grid is currently one of the most secure and stable electricity grids in the world. However, the demands on the grid have changed due to market liberalisation and the increase in energy generation from renewable energy sources. The Swiss transmission grid is already affected by structural congestion today. In order to remedy this and to equip the grid for future challenges such as the energy transition, Swissgrid maintains and modernises the infrastructure on an ongoing basis, thereby ensuring a sustainable energy future for Switzerland.

## 6,700 km
Swissgrid maintains more than 6,700 kilometres of extra-high-voltage lines and 12,000 pylons throughout Switzerland.

## 42 km
The proportion of underground cables in Swissgrid's transmission grid is less than 1%.

## 260,000
screws were installed by the grid electricians on the pylons for the extension of the 50-kilometre Pradella–La Punt line.

## 15 cm
is the diameter of a 380-kilovolt underground cable at extra-high-voltage level.

## 40 tonnes
A cable reel can weigh up to 40 tonnes.

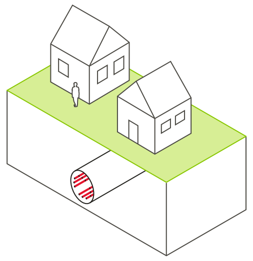
## 15 years
or longer can be necessary from the start of a project to commissioning before an infrastructure project can be put into operation. This is due to lengthy authorisation procedures, objections and court rulings.

Picture on page 2: Laying the cable conduits for the Beznau–Birr grid project

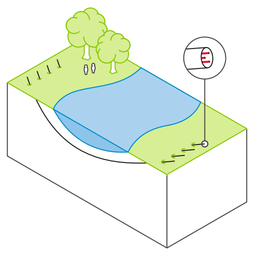
# Construction methods for line projects

## Route construction: how a cable is laid in the ground

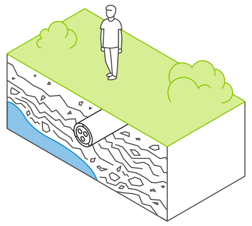
How are transmission lines laid underground? Which methods are suitable for which terrain – and how do they affect construction time, costs or load-bearing capacity? When planning lines, Swissgrid always looks for the best possible way to reconcile the four areas of economic efficiency, technology, spatial development and the environment. The "Lines construction kit" is an important tool for finding solutions. It gives a precise description of the advantages and disadvantages of the various possible solutions whilst addressing the need to carefully weigh up all the construction options.



**Tunnelling**
This method is chosen for rocky, mountainous terrain or for passing under obstacles such as residential areas or railway tracks. Accessible tunnels are built using tunnel construction or pipe jacking, and the cables are guided on special cable carriers. The tunnel profile is relatively large, which means that a considerable amount of material needs to be excavated.

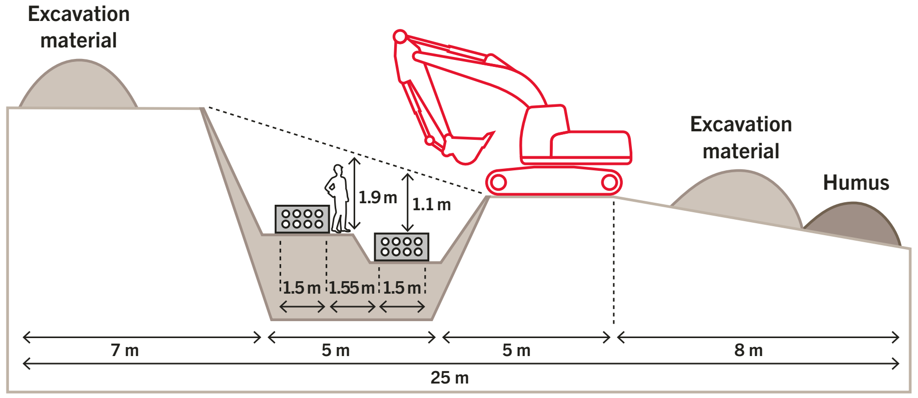


**Controlled drilling**
A direction-controlled drill head digs its way underneath obstacles such as bodies of water, roads or service lines. Stabilising liquid is pumped behind the drill head. Then empty conduits for the cables are laid.



**E-Powerpipe**
The E-Powerpipe is an innovative small drilling machine with horizontal directional drilling via individual tubular elements. The method has a particularly high progression rate and therefore results in low costs. It is used for near-surface tunnelling in loose rock, both in dry soil and in groundwater.

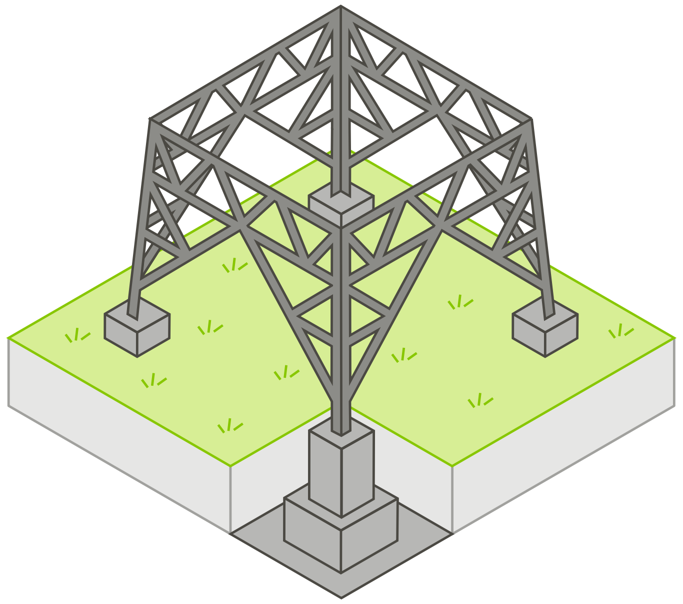
**Cable conduit blocks**
Most underground cables are laid using the open trench method. This requires the excavation of a trench to a depth of around 2 metres. A construction road of approx. 25 metres in width is needed for trench excavation, temporary storage of excavated material and construction slopes. Cable conduits are laid in these trenches using moulds. They are then concreted into cable conduit blocks, and the entire trench is backfilled with earth. Finally, the power cables are pulled into the cable conduits.

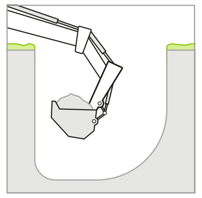




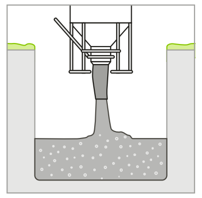

## Overhead line construction: stable foundations

Swissgrid maintains more than 6,700 kilometres of extra-high-voltage lines and 12,000 pylons throughout Switzerland. Many of them are located in challenging terrain: in mountainous, steep locations that are often difficult to access, on rocky, sometimes unstable ground. The pylon of an extra-high-voltage line requires a maximum area of 15 × 15 metres. Its foundation, which consists of four bases, is very stable: it must not only support the pylon, but also ensure that it does not tip over in strong winds. Depending on the height of the pylon and the terrain – especially in the mountains, where pylons are often located on steep or unstable terrain – additional safety measures may be necessary. Special measuring instruments monitor the smallest underground movements down to a depth of 25 metres. Structural measures such as metal nets or concrete reinforcements protect the pylons from avalanches, rockfalls or falling debris

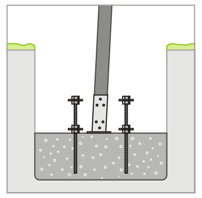




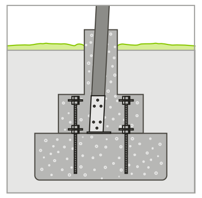
A shaft is excavated at the future pylon site – using excavators, pneumatic drills or mining methods, depending on the terrain.



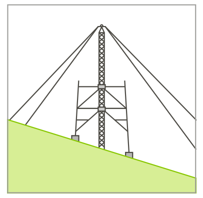
The shaft walls are secured and reinforced. Concrete is then poured into the bottom of the shaft to form the foot of the base, which can measure up to 4 × 4 metres.



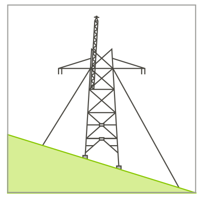
The lowest steel elements of the pylons are anchored into the concrete. In addition, metal posts are embedded into the foundations for reinforcement and stability.



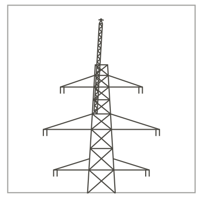
The steel elements are covered with several layers of reinforced concrete. The base tapers towards the earth's surface in several stages.



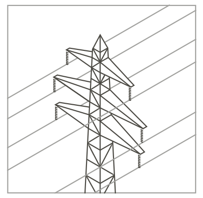
Once the foundations have been concreted, the pylon can be erected using a mobile crane, helicopter or – as shown in the illustration – an assembly tower.



Helicopters or lorries bring the pylon elements to the site, then the assembly tower hoists them up piece by piece.



The pylon grows continuously upwards. On steep terrain, individual pylon elements are attached by helicopter directly from the air.



When the pylon has been fully assembled, the power cables – called the conductors – are hooked to the insulators using pulleys.

# Maintenance and operation

Overhead lines and underground cables have advantages and disadvantages when it comes to operating and maintaining the grid. Technical challenges such as ensuring voltage stability increase as the number of underground cable sections of the transmission grid rises. This is because the two technologies have different electrical properties that affect the stability and availability of the transmission system.

## Maintenance and service life

### Overhead lines

Overhead lines and pylons are regularly inspected and maintained to ensure that the transmission system remains available at all times. The service life of an overhead line is around 80 years. The land under an overhead line can be farmed without any major restrictions – subject to safety rules

### Underground cables

An underground cable route includes transitional structures, the cables themselves and sleeve shafts. According to current estimates, the service life of an underground cable is around 40 years. The ground above the cable conduit block can be used again for agriculture and vegetation. As roots could damage the underground cable, however, the route must be kept clear of tall or deep-rooted trees.

## Disturbances

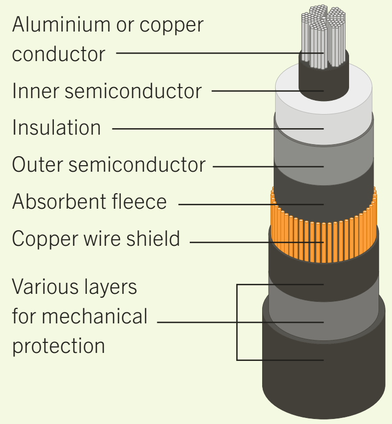
### Overhead lines

Overhead lines are more exposed to natural influences such as lightning, ice or falling trees than underground cables. They are therefore more frequently affected by disturbances and interruptions than underground cables, which are well protected in the soil. However, problems affecting overhead lines can usually be rectified within a few minutes or hours.

### Underground cables

Disturbances rarely occur on underground cables, although they take much longer to resolve than on overhead lines, because if a fault does occur, it will generally result in damage to the underground cable, which will then need to be replaced. This can take several weeks to months, as cables are made to measure and produced especially for each individual project. Removing damaged cable and laying new cable can also take a long time due to the high weight of underground cables.

**Structure of an underground cable**




**Underground cable with polyethylene (XLPE) as the insulation material**

Various cable technologies are used at extra-high-voltage level. The main differences lie in the insulation material that the conductors are enclosed in. This can consist of gas, compressed air or polyethylene. Each of these technologies has advantages and disadvantages. Underground cables with polyethylene as the insulation material are the standard for extra-high-voltage cables, and have been used by Swissgrid in Bözberg (AG) and between La Bâtiaz and Le Verney (VS). They are very versatile, as they are used in concrete cable boxes, in tunnels and even under water, for example on the 150-kV line between Brusino and Morcote (TI). The core of the cable consists of a copper or aluminium conductor, which is encased in several layers of polyethylene. Additional layers are used for sealing, mechanical protection or operational earthing of capacitive and short-circuit currents. The disadvantage of this technology is the weight.

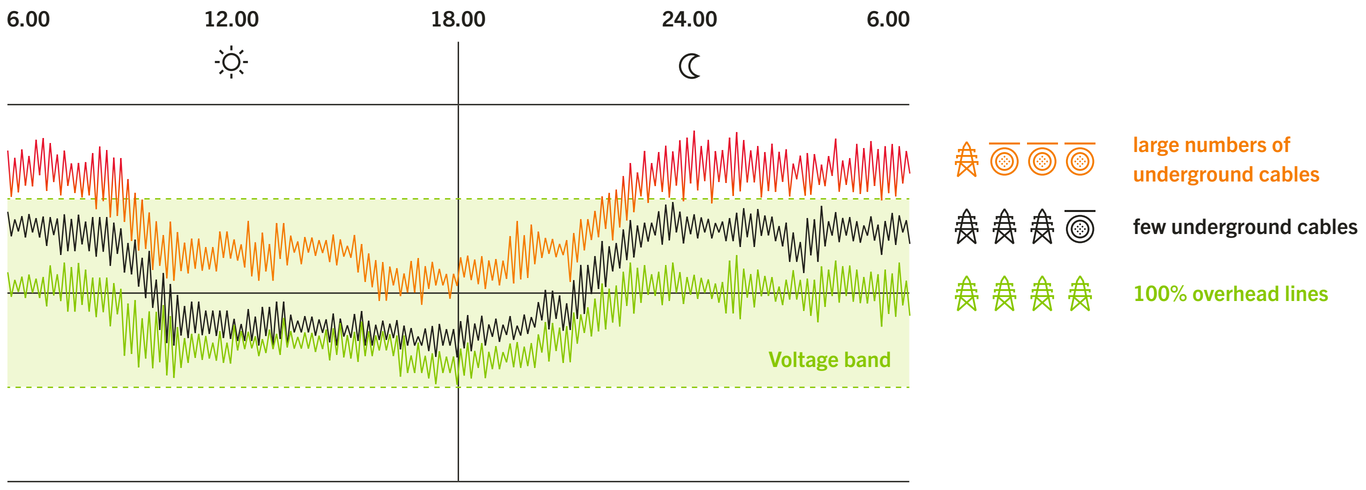
← Installation work for the Mörel–Ulrichen line project

# Long underground cables, major challenges

Swissgrid is open to the use of all technologies, and examines the overhead line and cabling options for every project. When assessing their advantages and disadvantages, it is important to consider not only the individual line section, but also the grid as a whole. Physical phenomena and operational challenges limit the use of underground cables in the transmission system. Swissgrid supports technological innovations and pilot projects for the grid of the future.

**Voltage maintenance**

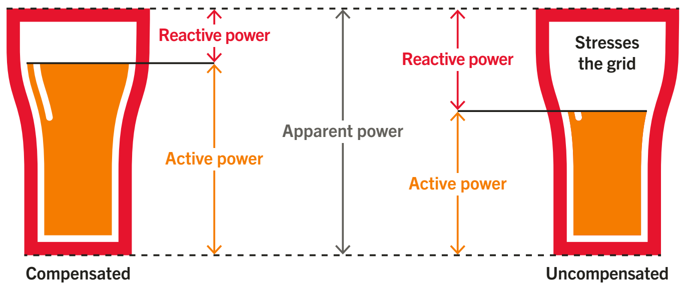
Swissgrid's grid control room monitors the voltage in the transmission system around the clock to ensure that it remains within a certain band. Otherwise, there is a risk of damage to electrical systems. Due to their physical properties, underground cables increase the voltage much more than overhead lines. If the number of kilometres of underground cable in the transmission system increases, the usual measures taken to maintain voltage – i.e. instructing power plants to increase or reduce their production – are no longer sufficient. Compensation systems may be needed, for instance. However, these systems require a lot of space, are expensive and cause noise. Furthermore, additional technical components increase the degree of complexity and hence susceptibility to faults in the transmission system.




Cable tunnel between La Bâtiaz and Le Verney in the Martigny area (VS)

**Reactive power**

Reactive power is like the foam that fills the top of the glass and leaves less room for the beer. Physically, a distinction is made between capacitive and inductive reactive power, which compensate for each other and ideally cancel each other out completely. Swissgrid tries to operate its lines as closely as possible to this point, which is referred to as "natural power". This is not possible with underground cables as they would heat up too much. Long underground cables therefore either reduce the effective power of a line (active power) or require systems to compensate for the reactive power. This difficulty increases in proportion to the length of the underground cable.

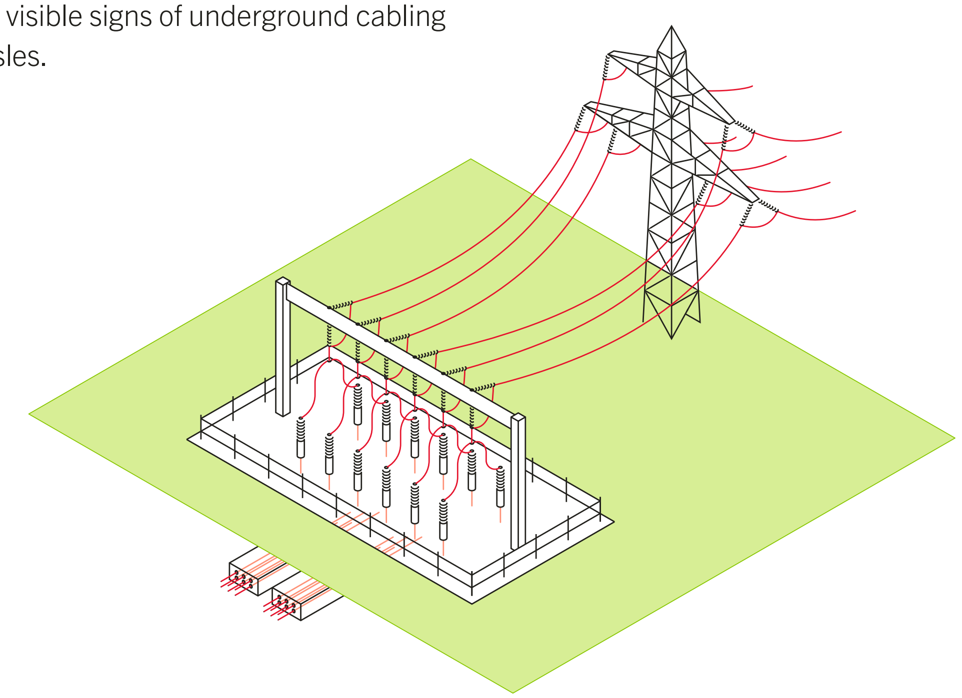



**Electrical losses**

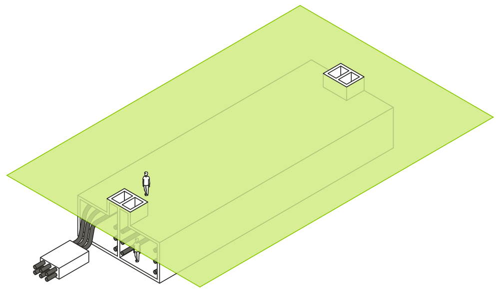
Electrical energy is always lost when electricity is transported. The active power losses depend on the transmission power. They are higher for overhead lines than for underground cables. If the losses due to the compensation of reactive power are added to the figures for underground cable lines, the total losses are approximately the same for both transmission technologies.

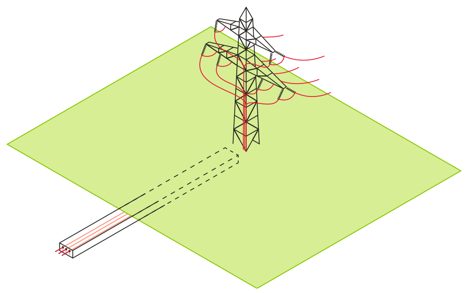
# Visible elements of underground cabling

Protecting the landscape is a major advantage of underground cabling. The majority of the line infrastructure is in the ground – and therefore invisible. However, underground cables also leave traces in the landscape, for instance in the form of aisles in forests, access roads and transitional structures that connect overhead lines to the underground cables. Special shaft constructions are used to inspect and repair the cable connections. The voltage is stabilised with compensation systems. Other visible signs of underground cabling include access roads and forest aisles.



**Transitional structures**
Transitional structures are needed to connect the underground cables to the overhead lines. They stand out for the guyed scaffolds that protrude around 25 metres into the sky. They take the lines from the last pylon and connect them to the underground cables. Transitional structures require an area roughly the size of an ice hockey rink. When planning partial underground cabling, Swissgrid aims to integrate them into the landscape as inconspicuously as possible.



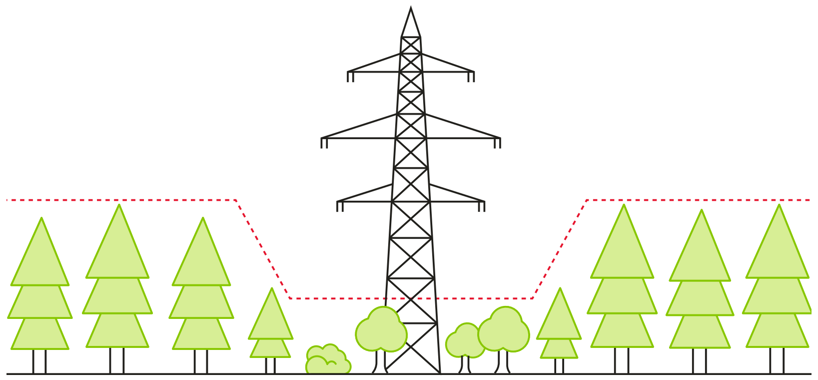


**Coupling and guide rail shafts**
Extra-high-voltage cables laid in the ground consist of numerous layers. The resulting weight is considerable. This means that the cables can only be pulled into the cable conduit blocks in sections measuring approximately one kilometre in length. The cable sections are joined with special connectors called couplings. This is technically demanding, which is why couplings are relatively susceptible to faults – and need to be constantly accessible. Special coupling shafts are therefore installed for repair and assembly work. Special shafts are also required for the guide clamps – these clamps prevent the underground cables from slipping on steep hillsides.

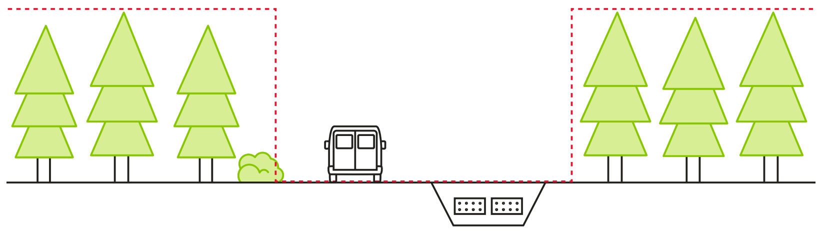
**Cable end pylons**
At the transition pylon, the line is routed from the underground section directly upwards onto the overhead line. Cable end pylons can be used for 220-kV lines in particular.



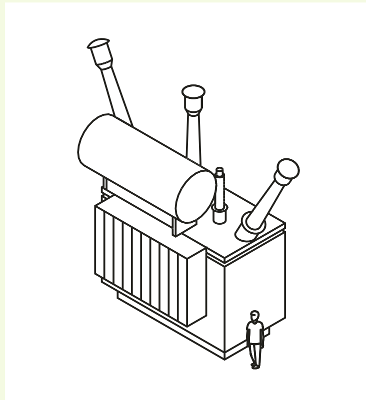
Construction of the new line in Goms (VS)



**Deforestation and aisles for overhead lines**
The construction of overhead lines in forest areas requires deforestation, for example for access routes, depots or the construction of pylon foundations. Some of these areas can be reforested once the construction work has been completed. Only low-stemmed trees may be planted directly under overhead lines.



**Deforestation and aisles for underground cables**
If underground cables cross forest areas, deforestation is necessary to create space for the construction of the cable trench. Some of these areas can be reforested once the construction work has been completed. However, as roots could cause damage, an aisle must be left permanently clear above the cable conduit blocks (as a clearance zone). Permanent deforestation is also necessary if transitional structures are built in the forest.



**Compensation systems**
Underground cables increase the voltage in the grid more than overhead lines. Swissgrid needs to ensure that the voltage across the entire transmission grid does not become too high. Swissgrid can either instruct power plants to reduce the voltage or build compensation systems to do the same thing. These systems are positioned next to a transitional structure or a substation where possible, but in some cases also in open terrain. Depending on the power, a compensation system is roughly the size of a lorry.

# Maximum protection for people and the environment

Swissgrid makes every effort to avoid or minimise negative impacts on people, the environment and the landscape during construction projects. The legal framework in Switzerland imposes strict limits for noise and electric and magnetic fields. However, Swissgrid also implements measures that go beyond the official requirements, for example by taking a range of steps to actively promote biodiversity.

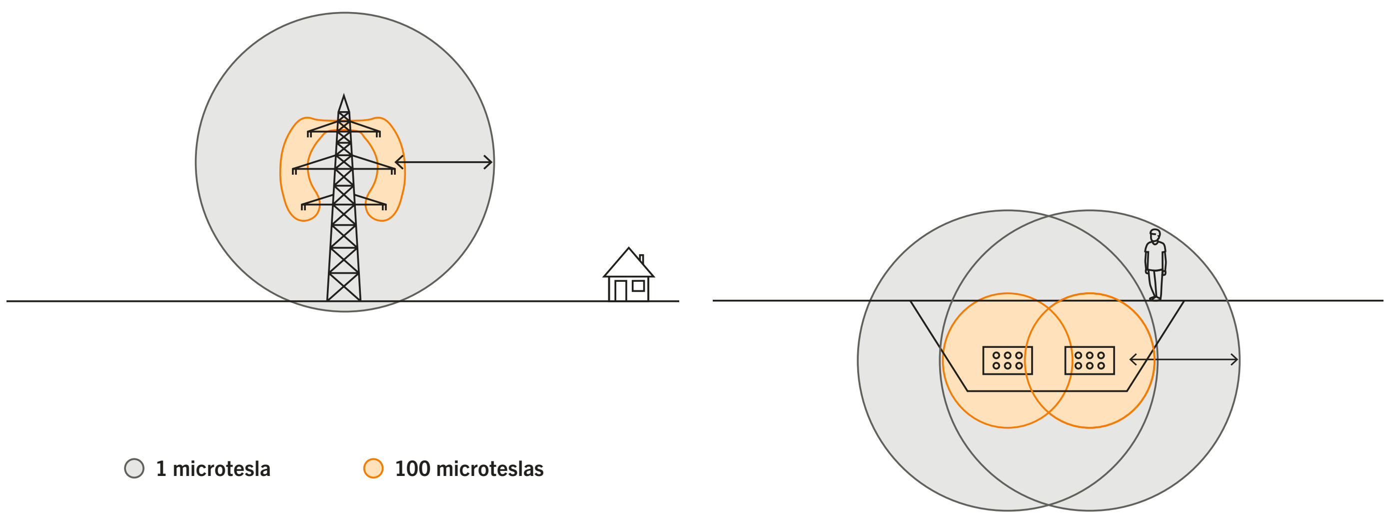
## Electric and magnetic fields

What we colloquially call "electromagnetic radiation" is not actually radiation, but electric and magnetic fields. These fields arise wherever electricity is generated, transported and utilised. The electromagnetic fields from overhead lines and underground cables differ primarily in terms of their reach. The Swiss limits that apply to both are among the strictest in the world.

The magnetic field is weaker directly under an overhead line than directly over an underground cable. On the other hand, the reach of the magnetic field is lower from an underground cable because the arrangement of the cables partially cancels out the fields. The installation limit for underground cables must be complied with from a lateral distance of six to eight metres. For an overhead line, this requires 60 to 80 metres.

**A crackle in the air**

Extra-high-voltage overhead lines constantly generate minor electric discharges into the air. This physical effect, referred to as a "corona discharge", generates sounds that the ear perceives as crackling or humming. If the air contains a high level of moisture – e.g. due to rain, hoar frost, wet snow or after a thunderstorm – the corona effect increases, and the crackling becomes louder. Underground cables themselves do not generate any noise emissions, but the same cannot be said for their connected infrastructures, such as transitional structures or compensation systems.






Transitional structure in Riniken (AG) for the Beznau–Birr grid project

## Beznau–Birr underground cable: effects on the soil and the environment

As the number of kilometres of cable grows, so does our knowledge about the technical, operational, economic and ecological effects of underground cables. For example, Swissgrid is analysing the temperature behaviour of the cable conductors and the magnetic fields under various loads and operating conditions on the 1.3-kilometre-long Gäbihübel cable section in the Bözberg/Riniken region in the Canton of Aargau, which was completed between 2018 and 2020. The effects of the underground cable on the soil were also recorded in an environmental monitoring programme. The study found that soil quality and earthworm populations were not affected by the transformation of the terrain and the slightly higher soil temperature in the first two years after the underground cable was commissioned. The soils are well colonised with earthworms, which indicates favourable soil conditions.

**To the video about Beznau–Birr underground cabling: impacts on the soil and the environment**

The underground cabling of the Beznau–Birr line illustrates the impact of underground cabling of a 380-kV extra-high-voltage line on the landscape and the environment and shows the challenges involved in construction, operation and maintenance.

**Promoting biodiversity**

In many places, the pylons and the areas directly below or next to them are suitable for promoting biodiversity by means of small structures. Swissgrid actively establishes habitats for plants and animals near pylons, substations or transitional structures – by creating ponds, making piles of branches or stones, or by preserving or promoting valuable rough pastures.

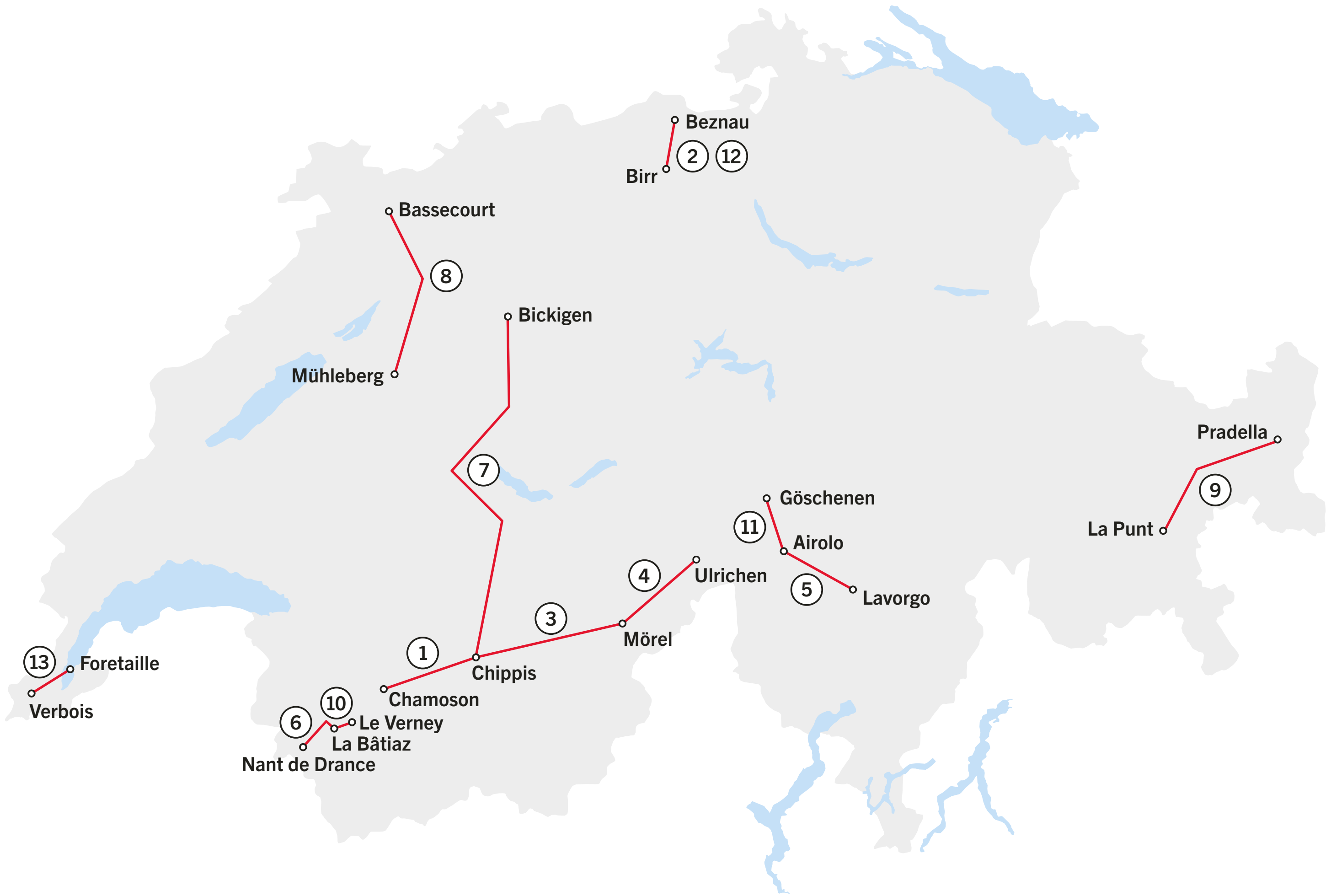
**Example of amphibians**

Small ponds can be created near pylon foundations. This benefits various amphibians such as the endangered yellow-bellied toad. Their habitat is declining more and more due to the loss of wetlands.

# Costs

The construction costs of an extra-high-voltage line can vary a great deal from case to case – depending on the topography, subsoil, potential natural hazards and the chosen technology. As a general rule, a kilometre of underground cable in the transmission system is around two to ten times more expensive than a kilometre of overhead line. When assessing economic efficiency, Swissgrid takes into account not only the construction costs, but also the life cycle costs of the various line variants.

Swissgrid's calculation is based on a line service life of 80 years. However, various components must be replaced sooner. In the case of underground cables, the underground cables themselves are a particularly important cost factor. Due to their technical life expectancy, underground cables can only be operated for half as long as overhead lines and have to be replaced completely after around 40 years.






## Overhead line

| New construction | Length | Total construction costs | Construction costs per kilometre |
|---|---|---|---|
| (1) Chamoson–Chippis | 30 km | CHF 140 million | CHF 4.7 million |
| (2) Beznau–Birr, overhead line sections | 5,2 km | CHF 12.1 million | CHF 2.3 million |
| (3) Chippis–Mörel | 44 km | CHF 120 million | CHF 2.7 million |
| (4) Mörel–Ulrichen | 30 km | CHF 110 million | CHF 3.7 million |
| (5) Airolo–Lavorgo | 23 km | CHF 82 million | CHF 3.6 million |
| (6) Nant de Drance grid connection, overhead line sections | 12,5 km | CHF 55 million | CHF 4.4 million |

| Voltage increase of existing overhead lines | Length | Total construction costs | Construction costs per kilometre |
|---|---|---|---|
| (7) Bickigen–Chippis | 106 km | CHF 85 million | CHF 0.6 million |
| (8) Bassecourt–Mühleberg | 45 km | CHF 17 million | CHF 0.4 million |
| (9) Pradella–La Punt | 50 km | CHF 73 million | CHF 1.5 million |

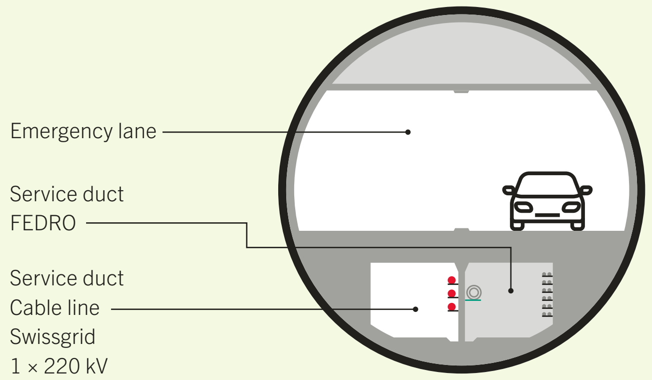
## Underground cabling

| Partial underground cabling | Length | Total construction costs | Construction costs per kilometre |
|---|---|---|---|
| (10) La Bâtiaz–Le Verney | 1,2 km | CHF 35 million | CHF 29.1 million |
| (11) Airolo–Mettlen (Gotthard underground line) | 18 km | CHF 107 million | CHF 6 million |
| (12) Beznau–Birr, Gäbihübel underground line section | 1,3 km | CHF 20.4 million | CHF 15.7 million |
| (13) Foretaille–Verbois, Axe Réseau Stratégique Genève | 4,7 km | CHF 46.4 million | CHF 9.9 million |

**Bundled through the mountain – Airolo–Mettlen (Gotthard line)**

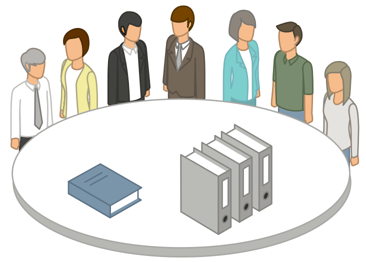
In recent years, Swissgrid has installed underground cable lines with a total length of over 40 kilometres in the transmission system. Swissgrid bundles underground cables with other infrastructure projects wherever possible and whenever it makes sense to do so. The construction of the second tube of the Gotthard Road Tunnel by 2029 offers Swissgrid a wide range of opportunities. The combination of an extra-high-voltage line with a motorway tunnel is a pioneering project that is the first of its kind in Europe. Swissgrid can gain valuable experience from this technically demanding project. Another plus is that the burden on the Gotthard landscape will be relieved by dismantling 23 kilometres of overhead lines and 70 pylons.

**Cabling in the road tunnel**



# Basis for decision-making

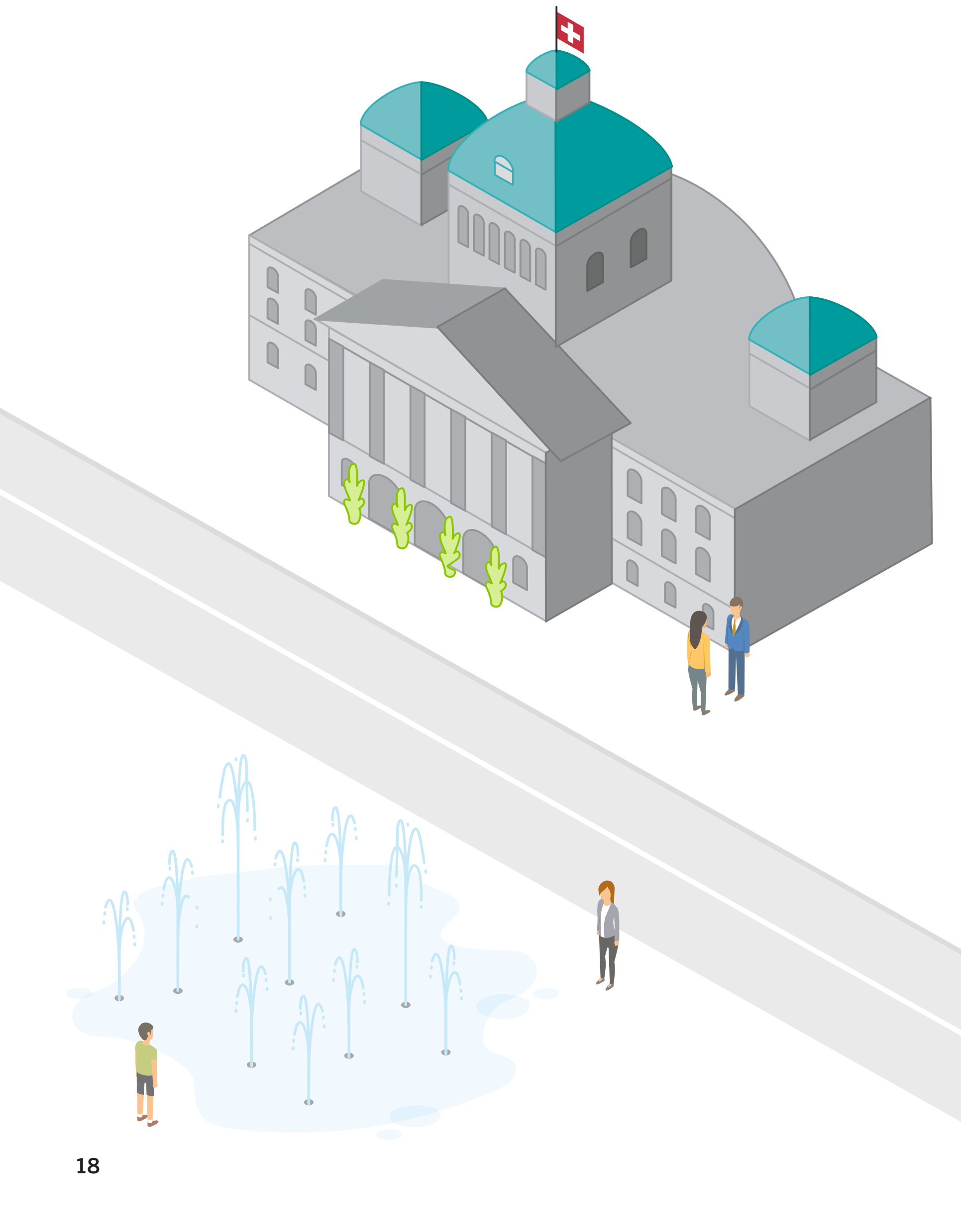
The Federal Council decides during the approval process whether a section of line should be implemented as an underground cable or an overhead line. The decision made as part of the transmission lines sectoral plan involves weighing up all the interests. The recommendation of the monitoring group set up by the Swiss Federal Office of Energy (SFOE) plays an important role. This group is tasked with making the discussion more objective and enabling impartial and clear decisions to be made. A special evaluation scheme to assess the four areas of economic efficiency, technology, spatial development and the environment is available as a tool.



**Who is in the monitoring group?**
The monitoring group is chaired by the Swiss Federal Office of Energy. Depending on the project, the monitoring group is made up of representatives of several federal offices (e.g. spatial development, environment, transport), the Federal Inspectorate for Heavy Current Installations (ESTI), the Federal Electricity Commission (ElCom), representatives of the affected cantons, an environmental protection organisation and Swissgrid. Each party has one vote.

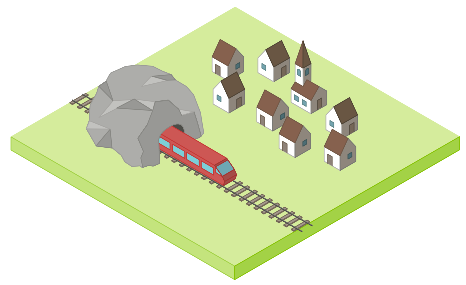
**What role does the monitoring group play?**
It submits recommendations to the Federal Council for determining the planning territory and planning corridor and for defining the type of technology (overhead line or underground cable). For this purpose, it discusses and evaluates the versions prepared by Swissgrid. Various federal offices introduced a special methodology a few years ago, the "Transmission lines evaluation scheme", to make sure that the best possible solution can be found. It allows the strengths and weaknesses of the variants to be weighed up objectively, comprehensively and systematically.

**How does this evaluation scheme work?**
The scheme is based on the four areas of spatial development, technical aspects, environmental protection and cost-effectiveness. Each of these areas comprises three to four groups of criteria, each with two to seven sub-criteria, which are all weighted differently. The monitoring group assigns points to the criteria and multiplies them by the relevant weighting. Economic efficiency is an exception, as the real costs are taken into account. The comparison of the figures obtained establishes a basis for decision-making, but the members of the monitoring group nonetheless still weigh up the interests of each specific variant.



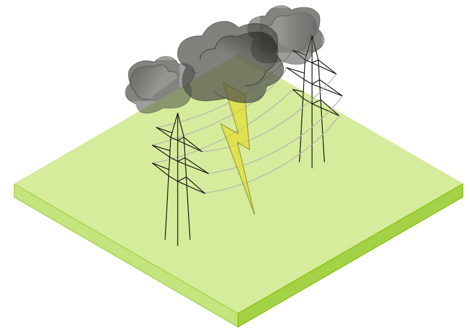


**Evaluation scheme for transmission lines**



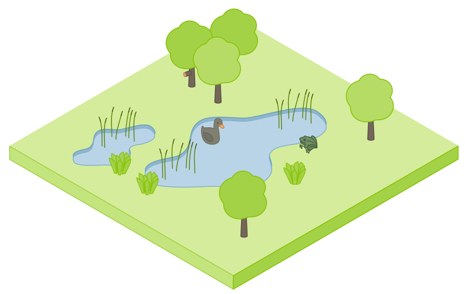
**Spatial development – restricting space requirements, bundling infrastructures**

- **Conservation of resources**
  The chosen option should utilise the available space as economically as possible and, where possible, always be bundled with other infrastructure or use existing routes.
- **Protection of residential areas**
  Good agricultural land must be protected, as must residential areas. Protected townscapes and monuments, recreational zones and tourist attractions must be avoided.
- **Definition of planning goals**
  Overarching plans, projects and concepts must be taken into consideration.



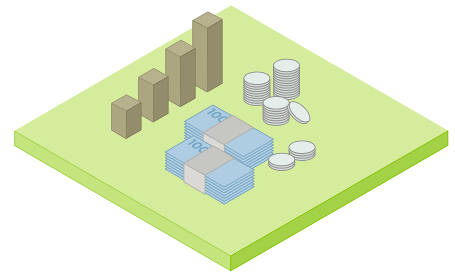
**Technical aspects – guaranteeing security of supply, minimising losses**

- **Grid operations**
  The variants must satisfy technical minimum requirements – e.g. in relation to their permissible load, susceptibility to faults or duration of repair.
- **Reliability and safety**
  The risk from natural hazards or weather influences must be assessed.
- **Life cycle**
  The energy losses are calculated and a life cycle assessment is drawn up over the entire life cycle of the variants.



**Environment – complying with limits, protecting natural resources**

- **Immission control**
  Clear, measurable limits apply for the protection of people and nature from excessive exposure to electromagnetic radiation and noise. These limits must be complied with.
- **Landscape conservation**
  When it comes to the landscape, the guiding principle is "maximum protection". Each section of landscape must be reassessed. Conservation areas of national importance may only be affected if there are no alternatives, and if an overarching national interest exists. Biotopes, migratory bird reserves, groundwater protection zones and water areas must also be taken into account.



**Economic aspects – calculating costs comprehensively, ensuring efficiency**

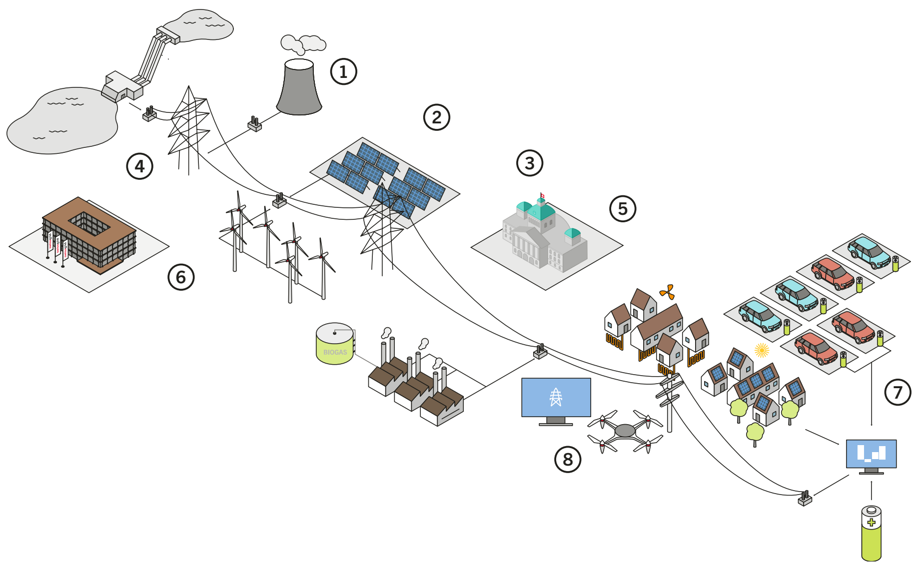
- **Investment and operating costs and income**
  This involves estimating costs – effective or standardised (costs per kilometre), including the investments and replacement investments over the entire service life, as well as investments for support measures.
- **Allowable costs**
  Every grid project must be evaluated by the regulator from an economic perspective, since the costs are passed on to consumers in their electricity bills.

# Grid of the future

Switzerland's electricity system is in the midst of the greatest upheaval in its successful history. Electricity generation is becoming increasingly volatile due to new decentralised energy sources and power plants, as well as growing electricity generation from renewable energies. Battery technologies and pumped storage power plants are creating new storage possibilities. There are also additional consumers such as electric vehicles, heat pumps and data centres. This places new demands on the grid and poses a challenge for secure grid operation. In addition, a large proportion of the lines in Switzerland's transmission grid will reach the end of their technical service life in the next few decades and therefore need to be replaced. In order for the transmission system to meet future needs, it must be further developed in the long term. Swissgrid periodically draws up a multi-year plan for this purpose: the "Strategic Grid".

**The energy world of tomorrow**

The electricity industry is undergoing a process of radical change. The energy transition, smart technologies and the changing political and economic framework conditions are posing new challenges for energy companies. As the national grid operator, Swissgrid plays a central role as a link between electricity generation and consumption, and will continue to do so in the future.




1. Decarbonisation, loss of power plants with guaranteed power
2. Expansion of electricity generation from renewable energy resources
3. Volatile energy policy framework and regulatory environment
4. Sluggish expansion of the grids
5. Increasing exclusion from EU bodies as well as grid and market mechanisms
6. Risks due to global developments such as climate change, pandemics and cybercrime
7. Strong growth of decentralised, flexible resources via electrification
8. Major opportunities thanks to digitalisation and automation




Research at ETH Zurich's High Voltage Laboratory

**Fit for the energy transition thanks to digitalisation**

How can high-voltage electricity be transported as reliably and cost-efficiently as possible, without losses and in a way that is compatible with the landscape and the environment? To ensure that the transmission system meets the requirements of the future, Swissgrid relies on tested and proven technologies, monitors the technology market, and participates in innovation processes and pilot projects.

**For further information:**
**Research and development at Swissgrid**

The energy reform poses new challenges for the Swiss electricity grid. In-depth research and development work is needed to prepare the transmission grid for the future. Swissgrid cooperates with universities to develop the new technologies and methods required to enable the efficient and secure transmission of energy.

Print-powered climate project
No.: OAK-ER-00000-00000
www.oak-schwyz.ch/nummer

**Underground cable or overhead line? Let's talk about it.**
Book a guided tour of our visitor centre in Niederwil (AG) today and come and talk to us about the opportunities and challenges of underground cables and overhead lines in the extra-high-voltage grid.

Swissgrid Ltd, Bleichemattstrasse 31, 5001 Aarau, Switzerland
T +41 58 580 21 11, info@swissgrid.ch, www.swissgrid.ch